CABLE PLANT LAYOUT - SERVING AREA VALUE ENGINEERING FOR RURAL SYSTEMS

CONTENTS

1. GENERAL

1.01 This section provides REA borrowers, consulting engineers, and other interested parties with technical information covering cable plant layout utilizing the Serving Area Value Engineering (SAVE) concept for the design of rural telephone plant. It discusses in particular the following: (1) establishing long range serving areas, (2) introducing a Serving Area Interface (SAI) which provides a point where connection is made between feeder pairs and distribution pairs, (3) gradually converting feeder cable pairs in feeder-distribution cables to distribution use, and (4) converting to pair gain electronic devices to provide for feeder circuits. Although this section is written around buried telephone cable plant, it should also be kept in mind that the design concepts are applicable to an aerial cable plant.

1.02 During approximately 10 years of operation of the "Dedicated Plant Concept" in cities and towns, techniques have been developed which improve the feasibility of dedicated plant in rural all one-party exchanges and in exchanges changing rapidly from one-, two-, and four-party service to all one-party service. Dedicated plant for rural systems is also discussed in Telephone Engineering and Construction Manual, Section 628, "Plastic Insulated Cable Plant Layout".

1.03 Rural telephone cables almost invariably consist of a feeder complement and a distribution complement. Subscriber services are connected to the distribution pairs. Feeder or distribution pairs from other cables are connected to the feeder pairs. The Serving Area Value Engineering concept differs from the original dedicated plant concept of permanently connecting a subscriber to the central office, in that it introduces an interconnecting point, and it anticipates the gradual conversion to (1) feeder circuits using electronics and (2) converting the physical feeder pairs to distribution circuits.

1.04 The SAVE concept is more liberal in providing the initial distribution portion of the cable, and considers that in an area with growing telecommunication needs, a feeder-distribution cable would frequently be converted entirely to distribution use during the life of the cable.

1.05 When dealing with 4.5 or 9.0KF serving areas, the number of distribution pairs initially dedicated to a serving area should be based on guidelines in Section 230 and 231 of the TE&CM. Distribution pairs and physical feeders are generally provided initially in multiples of five. A reduced number of carrier feeders may be provided initially. To ease the transition into Serving Area operation, initially all the terminated feeder pairs can be interconnected to some non-working as well as working distribution pairs. This not only will reduce the subscriber assignment effort and station installer's workload but in contract construction these interconnections can be made at reduced cost.

1.06 The introduction of the Serving Area Interface which provides an interconnecting point and the "Home" count (pairs assigned to a specific housing) in distribution housings should substantially reduce troubles caused by plant personnel. In rural systems the SAI is expected to also result in substantial reductions in violations of transmission guidelines and in much more efficient copper usage by making it practical to (1) reassign feeder pairs and to (2) readily introduce electronic devices rather than additional feeder cable pairs. Cross-connect blocks, where used, also make it convenient to isolate trouble between the feeder and distribution plant. Where splicing connectors are used they can be removed for testing purposes and then replaced after testing. Section 648 of the TE&CM describes SAI arrangements in more detail.

1.07 Serving area boundaries, once established, constitute the ultimate boundary of the serving area. The optimum balance between feeder cable pair cost and distribution cable pair cost for serving areas within 5 or 6 miles of the central office has been found to range between 300 and 600 residential subscribers. Outside of suburban or vacation housing developments there are few such serving areas in rural systems. By initially using cable pairs for feeders that may ultimately be required for distribution use, it becomes practical to use Serving Area Value Engineering principles in rural areas where there may be as few as ten to twenty five subscribers in a serving area. The use of pair gain electronic equipment

such as concentrators and/or carrier, to increase the efficiency of feeder cable pairs, makes it possible to extend the Serving Area Value Engineering concept well beyond 6 miles.

1.08 In most rural systems, it will not be desirable to introduce a Serving Area Interface within 1 or 2 miles of the central office. The original dedicated plant concept of permanently connecting the subscriber's residence to the MDF with a separate cable pair will be more practical. Rural systems will find that the load coil housing is the logical location for SAI's between the feeder plant and the distribution pairs dedicated to the serving area. Rarely will the optimum 300 to 600 subscriber size serving area be exceeded when load coil locations are systematically used for the interconnection points.

1.09 Establishing the load coil location as the interconnecting point (SAI) for a rural serving area has the following principal advantages:

(a) It reduces the probability of plant forces introducing subscriber loop transmission problems.

(b) It eliminates unnecessary decision making on boundaries for a serving area.

(c) It permits a somewhat more liberal allocation of distribution pairs between the subscribers and the interconnecting point while maintaining only a 3- to 5-year allocation of feeder circuits.

(d) It reduces uneconomical tapering of rural cables by recognizing that new feeder-distribution cables within a serving area can be a uniform size because they will later have a re complement and may eventually become an all distrib Reduced size cables that do not extend more than 2 beyond the reduction point should be avoided. Serv Interfaces are logical locations for reductions in sizes.

1.10 The location of an SAI is not tc as other locations might prove t route junction. (See Figure V).

2. SERVING AREA VALUE ENGINEERING

2.01 Since 1966, REA has considere locations as control points f See Telephone Engineering and Constr Engineering and Record System," for

presently using the dedicated plant concept generally restrict its use to the nonloaded portion of the system. Only the first two or three load coil locations from the central office have been in use as control points. Party line bridging of subscribers on these nonloaded cable pairs has been done at the MDF rather than at control points.

2.02 The Serving Area Interface (SAI) is a point where interconnection is made between feeder pairs and distribution pairs intended to serve subscribers within a specified boundary or serving area. The connection of feeder to distribution pairs can either be direct by means of splicing connectors, by fixed count terminal blocks or can be by means of cross-connect blocks utilizing jumpers to provide the connection. Normally the SAI is provided by a terminal housing mounted above ground to facilitate access to the connecting point.

2.021 Splicing connectors would normally be used where there are less than 25 feeder pairs assigned to the specific SAI. Also, splicing connectors may be used where there are 25 or more feeder pairs and a low level of activity is expected. Where there are a small number of pairs or a low level of activity it is relatively simple to remove the connectors and replace them after rearranging or testing. There should be sufficient slack in the conductors to permit the removal of connectors and the addition of new ones without having to "piece in" new lengths of conductor. This is true, particularly when new splicing arrangements are utilized.

2.022 Cross-connect blocks should be considered whenever there are 25 or more feeder pairs assigned to the specific SAI and sufficiently high activity (generally a high growth area) is anticipated to justify the higher cost. Cross-connect blocks provide for potentially better housekeeping, easier rearrangement and maintenance testing.

2.03 Good housekeeping is a primary factor for the SAI housing. It is important to separate the low activity splicing within the SAI from the high activity interconnection between feeder and distribution pairs associated with the serving area being served by the specific SAI. The use of cross-connect blocks, as mentioned above, facilitate good housekeeping within the SAI housing when making interconnections. However, splicing connectors are permissible for interconnections and the pairs involved should be grouped together to the extent possible and should be physically located to provide easy access to these pairs for future rearrangement and testing.

2.04 Within the SAI, connections are to be made only for new services and disconnections made only when (1) a service has been discontinued and (2) the associated feeder pair is required for a new service. Until the feeder pairs dedicated to a particular serving area approach capacity, services would normally be disconnected at the MDF rather than at the SAI.

2.05 To increase the application of the serving area design and to reduce the cost, two or more loading coil sections are generally combined into an enlarged serving area with 9KF-D66 end sections or non-loaded carrier subscriber loops. Such physically large serving areas should be planned to be easily subdivided when growth occurs. It should be kept in mind that some station carrier will not operate with a 9KF, 22 or 24 gauge pair, voice frequency drop beyond the subscriber terminal.

2.06 Serving areas more than 5 or 6 miles from the central office can generally best be served by electronic feeders. Electronic concentrators and/or carrier should generally be located in or adjacent to the SAI housing. It is advisable to dedicate one or more nonloaded cable pairs to all serving areas, even though initially some areas serve subscribers by loaded cable pairs exclusively. Serving areas where PCM type carrier may be required will require two or more nonloaded pairs. Where PCM carrier is intended, compartmentalized cable would be desirable but, if not available, then pairs should be selected to provide the greatest possible physical separation between the transmit and receive directions to minimize the possibility of near-end crosstalk.

2.07 Good plant records are considered a must for the SAVE program, or any design program, to function properly so as to realize maximum benefits. The records need to be maintained in a central location and should be updated on a continuous basis to reflect the actual situation currently existing. Theoretically, it would be helpful to have a written record of cable pair assignments for each SAI placed within the SAI housing. It is recognized that keeping up-to-date records in the SAI housings may not be practical although it would be helpful. In any event such records must be backed up by master records at a central location.

2.08 Proper identification of all cables within an SAI is of paramount importance. This should be done at time of initial installation and should provide a high degree of permanency to be useful over the life of the cables.

3. REFINEMENTS IN CABLE PAIR ASSIGNMENTS

3.01 Because most of the distribution pairs will be 9KF, systems providing all one party service should continue to cut off the non-working bridge taps when connecting subscriber services to the distribution pairs designated as the "Home" or preferred count. This also insures that there will be no load coils beyond the subscriber. Generally, only one of the two pairs in a buried service wire will initially be connected to a distribution pair.

3.02 Nonworking bridge taps beyond the branch point in the main cable should be removed when branch cables are spliced to the main cable. See distribution pairs 96 - 100D and feeder pairs 51 - 70E in Figure II.

3.03 To reduce the possibility of (1) introducing transmission errors or (2) inefficiently using copper for subscriber distribution not more than 25 pairs should be available for subscriber assignment in any individual distribution housing or ready access enclosure.

3.04 In small feeder-distribution cables, maintain 5 pair sub-group integrity for dedicated feeder or distribution use. Cables that are exclusively feeder and large feeder-distribution cables should maintain the integrity of 25 pair groups.

3.05 To maintain optimum fill in a 25 pair group that is subdivided into one or more branch cables, it is essential that one or more 5 pair sub-groups be the preferred count (Home Count) in the housings where the full 25 pair group is not assignable, but such subgroups should also be assignable in housings closer to the SAI where the entire 25 pair group is available. For example, in Figures I and II the five distribution pairs in the 25 pair cable and the eight distribution pairs in the 18 pair cable should also be assignable in distribution housings along the 100 pair cable.

3.06 When a buried reinforcing cable is to be installed along existing right of way, a determination should be made whether any portion of the new cable will eventually be required to provide distribution facilities along this portion of the right of way. Depending on how soon and how large a proportion of the new cable pairs will be required for distribution, a decision should be made on whether to run the new cable through some or all the existing buried distribution housings, whether some new housings for future distribution from the reinforcing cable should be installed, or whether a future housing and buried splice in the reinforcing cable should be counted on for relief.

3.07 To reduce operating problems, when the size of a new feeder-distribution cable will exceed 200 pairs, it is recommended that two cables be installed (100F, 200F-D; 150F, 150F-D; 200F, 200F-D; 200F, 300F-D; 300F, 300F-D; etc.)-- the first, an all feeder express cable of 100 pair or more that does not pass through distribution housings and the other a 150 or 200 pair feeder-distribution cable which may eventually become an all distribution cable as the feeder requirement is gradually transferred to new feeder cables or carrier facilities. A 200 pair all distribution cable can provide 2 pair for every 50 foot lot on both sides of a road for 1 mile. If this should ever prove inadequate and a paralleling cable on the opposite side of the road is not possible, inserting a new interface at the mid-point doubles this capacity.

2.05 To increase the application of the serving area design and to reduce the cost, two or more loading coil sections are generally combined into an enlarged serving area with 9KF-D66 end sections or nonloaded carrier subscriber loops. Such physically large serving areas should be planned to be easily subdivided when growth occurs. It should be kept in mind that some station carrier will not operate with a 9KF, 22 or 24 gauge pair, voice frequency drop beyond the subscriber terminal.

2.06 Serving areas more than 5 or 6 miles from the central office can generally best be served by electronic feeders. Electronic concentrators and/or carrier should generally be located in or adjacent to the SAI housing. It is advisable to dedicate one or more nonloaded cable pairs to all serving areas, even though initially some areas serve subscribers by loaded cable pairs exclusively. Serving areas where PCM type carrier may be required will require two or more nonloaded pairs. Where PCM carrier is intended, compartmentalized cable would be desirable but, if not available, then pairs should be selected to provide the greatest possible physical separation between the transmit and receive directions to minimize the possibility of near-end crosstalk.

2.07 Good plant records are considered a must for the SAVE program, or any design program, to function properly so as to realize maximum benefits. The records need to be maintained in a central location and should be updated on a continuous basis to reflect the actual situation currently existing. Theoretically, it would be helpful to have a written record of cable pair assignments for each SAI placed within the SAI housing. It is recognized that keeping up-to-date records in the SAI housings may not be practical although it would be helpful. In any event such records must be backed up by master records at a central location.

2.08 Proper identification of all cables within an SAI is of paramount importance. This should be done at time of initial installation and should provide a high degree of permanency to be useful over the life of the cables.

3. REFINEMENTS IN CABLE PAIR ASSIGNMENTS

3.01 Because most of the distribution pairs will be 9KF, systems providing all one party service should continue to cut off the nonworking bridge taps when connecting subscriber services to the distribution pairs designated as the "Home" or preferred count. This also insures that there will be no load coils beyond the subscriber. Generally, only one of the two pairs in a buried service wire will initially be connected to a distribution pair.

3.02 Nonworking bridge taps beyond the branch point in the main cable should be removed when branch cables are spliced to the main cable. See distribution pairs 96 - 100D and feeder pairs 51 - 70E in Figure II.

3.03 To reduce the possibility of (1) introducing transmission errors or (2) inefficiently using copper for subscriber distribution not more than 25 pairs should be available for subscriber assignment in any individual distribution housing or ready access enclosure.

3.04 In small feeder-distribution cables, maintain 5 pair sub-group integrity for dedicated feeder or distribution use. Cables that are exclusively feeder and large feeder-distribution cables should maintain the integrity of 25 pair groups.

3.05 To maintain optimum fill in a 25 pair group that is subdivided into one or more branch cables, it is essential that one or more 5 pair sub-groups be the preferred count (Home Count) in the housings where the full 25 pair group is not assignable, but such subgroups should also be assignable in housings closer to the SAI where the entire 25 pair group is available. For example, in Figures I and II the five distribution pairs in the 25 pair cable and the eight distribution pairs in the 18 pair cable should also be assignable in distribution housings along the 100 pair cable.

3.06 When a buried reinforcing cable is to be installed along existing right of way, a determination should be made whether any portion of the new cable will eventually be required to provide distribution facilities along this portion of the right of way. Depending on how soon and how large a proportion of the new cable pairs will be required for distribution, a decision should be made on whether to run the new cable through some or all the existing buried distribution housings, whether some new housings for future distribution from the reinforcing cable should be installed, or whether a future housing and buried splice in the reinforcing cable should be counted on for relief.

3.07 To reduce operating problems, when the size of a new feeder-distribution cable will exceed 200 pairs, it is recommended that two cables be installed (100F, 200F-D; 150F, 150F-D; 200F, 200F-D; 200F, 300F-D; 300F, 300F-D; etc.)-- the first, an all feeder express cable of 100 pair or more that does not pass through distribution housings and the other a 150 or 200 pair feeder-distribution cable which may eventually become an all distribution cable as the feeder requirement is gradually transferred to new feeder cables or carrier facilities. A 200 pair all distribution cable can provide 2 pair for every 50 foot lot on both sides of a road for 1 mile. If this should ever prove inadequate and a paralleling cable on the opposite side of the road is not possible, inserting a new interface at the mid-point doubles this capacity.

3.08 A maintenance pair should be provided along the entire length of each main lead from the central office to the last SAI on the lead. Pair No. 1 in each cable should be used for this purpose and should be nonloaded. It should be easily accessible at each SAI and where carrier cross-connect blocks are used it should be terminated on position No. 1. This maintenance pair would be available to be placed in service if absolutely needed.

4. ELECTRONIC FEEDER FACILITIES

4.01 Electronic pair gain devices such as carrier and concentrators are available which can provide the lowest circuit cost in many applications. Using single-channel carrier on a nonloaded cable pair it may be possible to provide as few as two circuits on a nonloaded cable pair of 18KF or less for lower cost per circuit than the cost of two physical pairs. For three or four times the cost of a single-channel carrier per circuit it is possible to increase the pair gain to 48 to 1. Service can be provided for 96 or more subscribers over two nonloaded PCM repeatered cable pairs in conjunction with a concentrator. In this case, if a standby span line and the interrogation and voice pairs cannot be shared by more tha one system, the pair gain is only 16 to 1. (See Figure V).

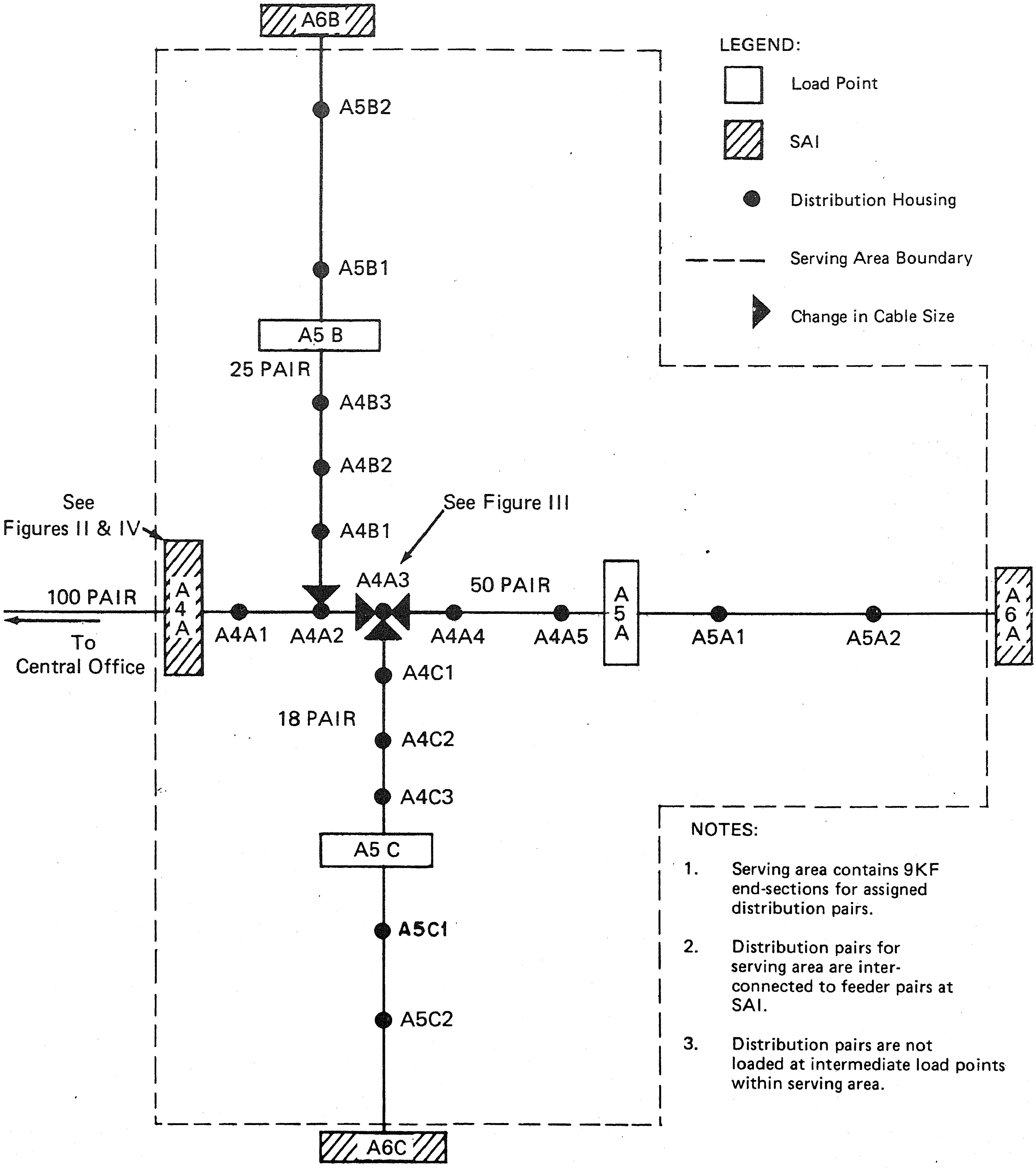
4.02 Station carrier and electronic concentrator costs have been reduced to the point where most of the feeder circuits more than 5 or 6 miles in length should be provided electronically. (See Figure V).

4.03 Six or seven channel per pair station carrier can be provided more economically and is easier to maintain if it is dropped in groups of 6 or 7 channels at a Serving Area Interface and inter-connected to distribution pairs much in the way that the 24 to 36 channel PCM systems designed for subscriber service have been used. The loop limits of the carrier must be coordinated with the serving area loop resistance.

4.04 The conventional rural installation of distributed station carrier with the carrier terminal placed near the subscriber should also be used when it is not economical to provide a distribution cable pair between each subscriber and the SAI. This would be thr parties served by a one-pair facility are to be upgrad service and it is uneconomical to replace the one-pair larger pair-count facility.

4.05 Concentrations of station or PCM subscriber carrier channels and the installation of electronic switching units at a serving area interface may also be used to advantage relatively close to the central office to increase high feeder fill until reinforcement with a large, low cost per pair, feeder cable becomes practical. Such units can be moved periodically to relieve congestion and maintain high efficiency in the feeder plant.

RURAL SERVING AREA

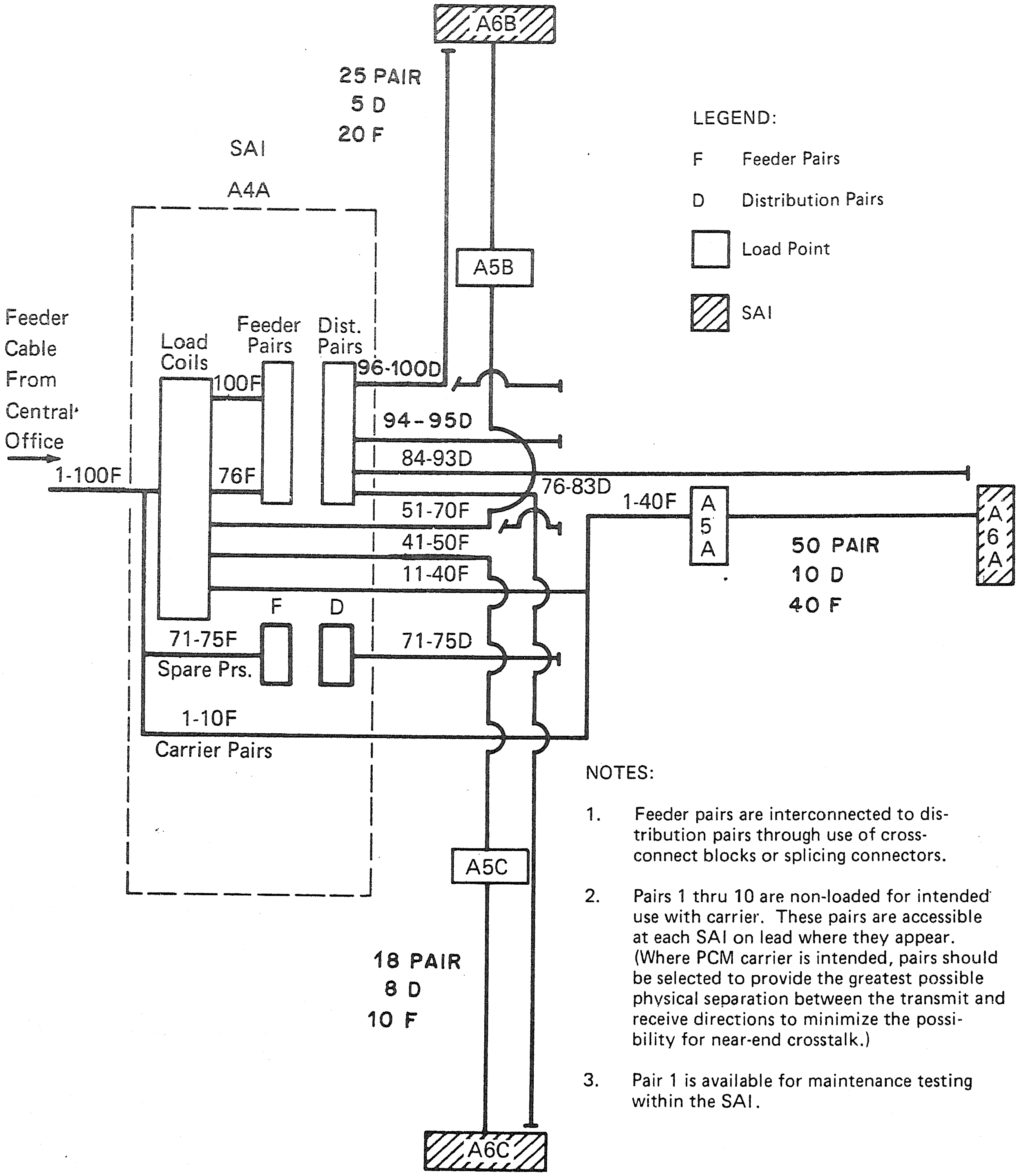


NOTES:

1. Serving area contains 9KF end-sections for assigned distribution pairs.
2. Distribution pairs for serving area are interconnected to feeder pairs at SAI.
3. Distribution pairs are not loaded at intermediate load points within serving area.

FIGURE I

SERVING AREA INTERFACE (SAI) — CABLE SCHEMATIC



NOTES:

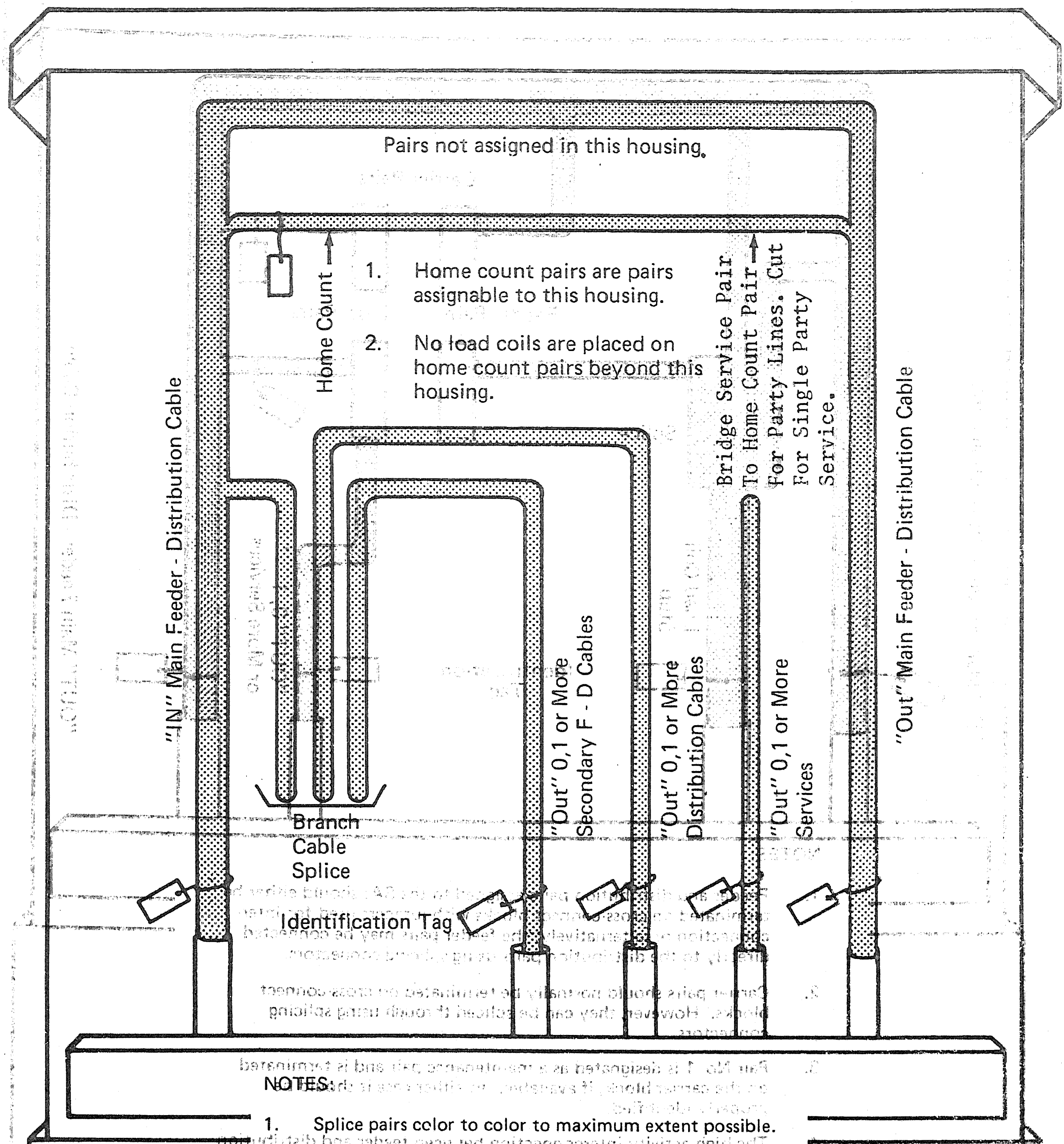
1. Feeder pairs are interconnected to distribution pairs through use of cross-connect blocks or splicing connectors.

2. Pairs 1 thru 10 are non-loaded for intended use with carrier. These pairs are accessible at each SAI on lead where they appear. (Where PCM carrier is intended, pairs should be selected to provide the greatest possible physical separation between the transmit and receive directions to minimize the possibility for near-end crosstalk.)

3. Pair 1 is available for maintenance testing within the SAI.

FIGURE II

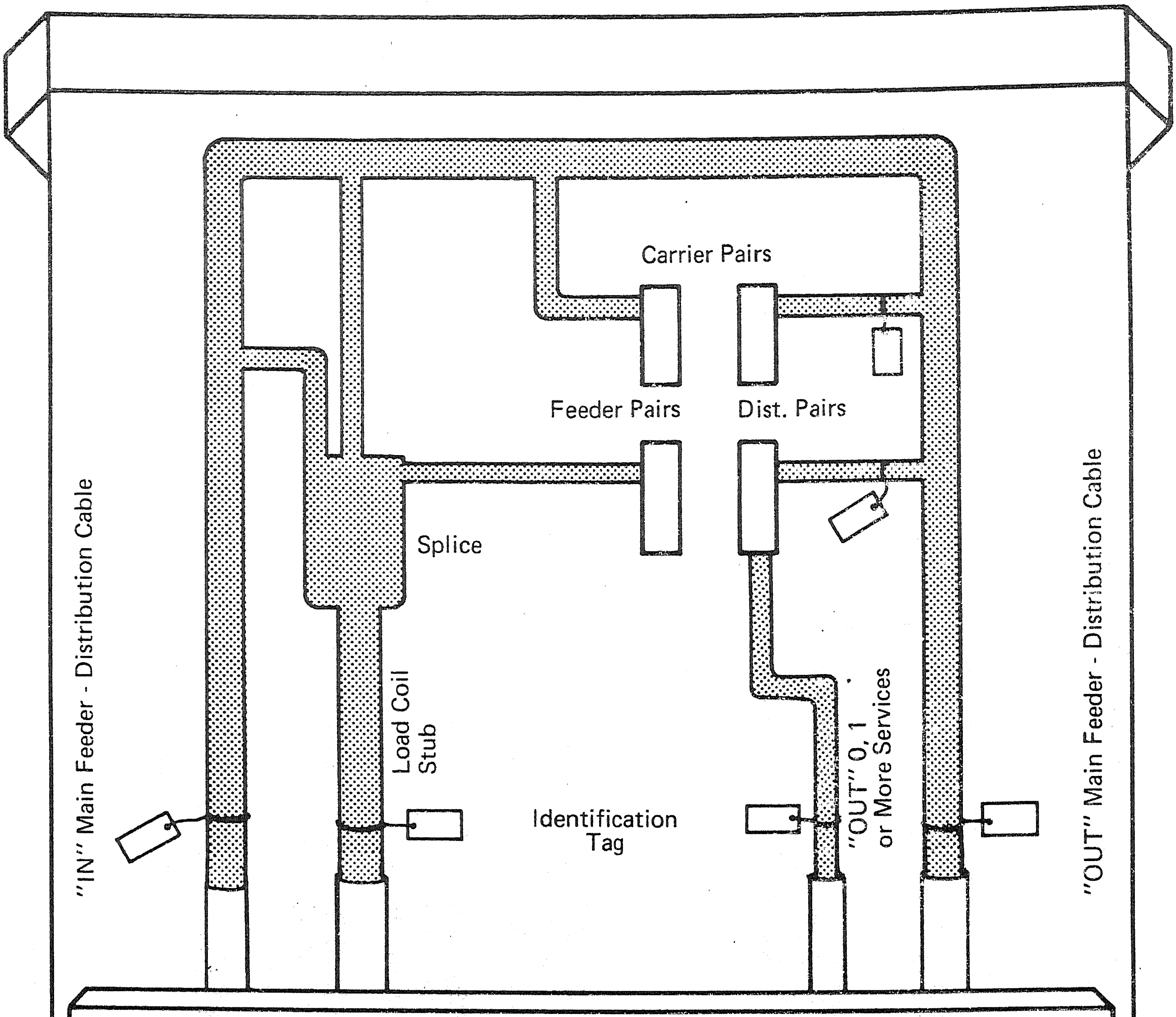
DISTRIBUTION HOUSING — CABLE LAY - UP



NOTES:

1. Splice pairs color to color to maximum extent possible.
2. No non-working bridge tap on thru cable.
3. Provide cable identification on tags attached to each cable.
4. See REA Splicing Standard PC - 2 for splicing instructions and physical arrangement within the housing.

SERVING AREA INTERFACE (SAI) HOUSING — CABLE LAY - UP



NOTES:

1. Feeder and distribution pairs assigned to the SAI should either be terminated on cross-connect blocks with jumpers used for interconnection or, alternatively, the feeder pairs may be connected directly to the distribution pairs using splicing connectors.

2. Carrier pairs should normally be terminated on cross-connect blocks. However, they can be spliced through using splicing connectors.

3. Pair No. 1 is designated as a maintenance pair and is terminated on the carrier block, if available. In either case it should be properly identified.

4. The high activity interconnection between feeder and distribution pairs and carrier pair terminations should be easily accessible and should be separated from the low activity splicing within the SAI.

5. See REA Splicing Standard PC - 2 for splicing instructions and physical arrangement within the housing.

FIGURE IV

SERVING AREA VALUE ENGINEERING (SAVE) SCHEMATIC

(Example Showing Section of a Cable Lead From Load Points A4A to A10A)

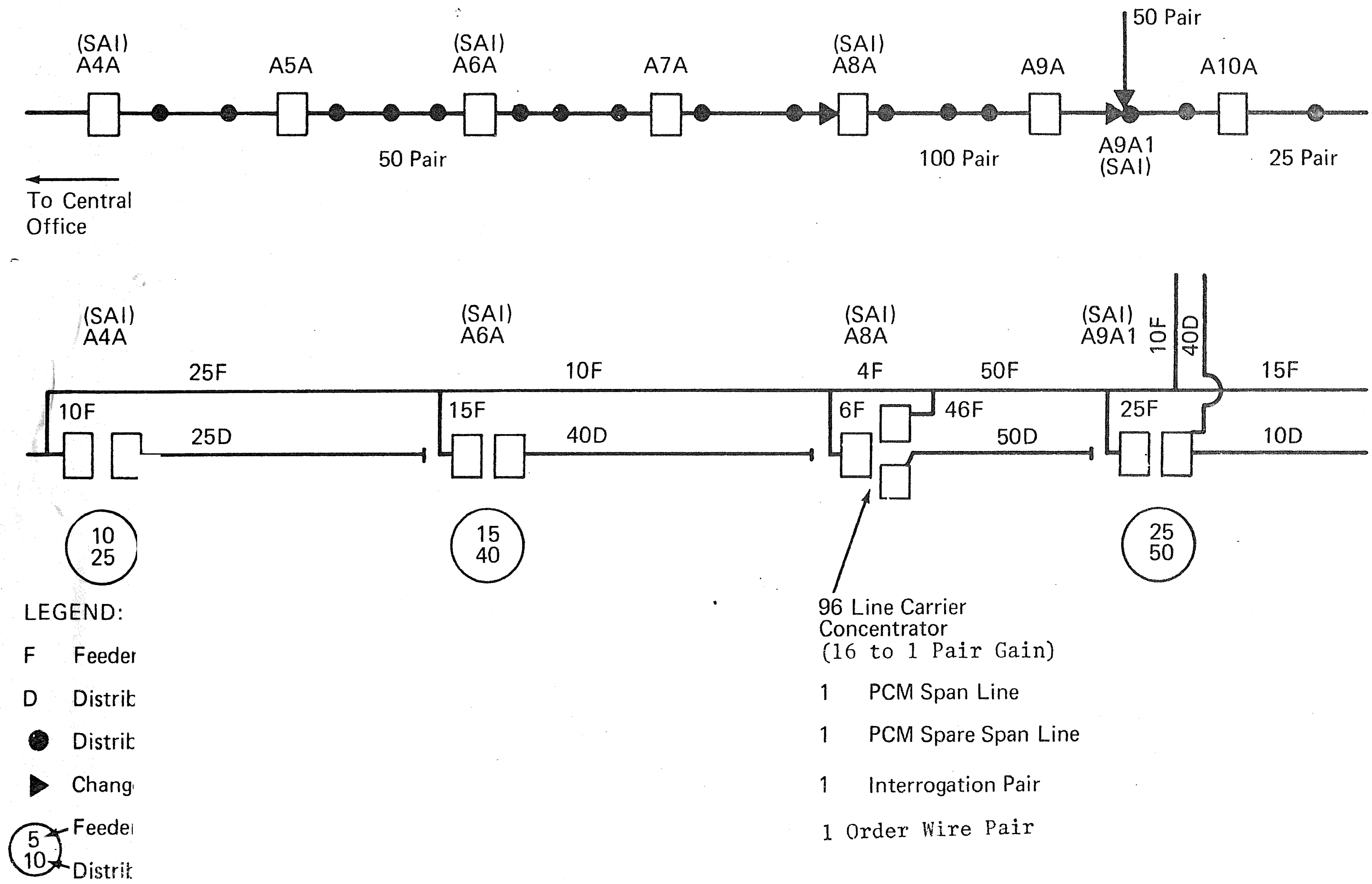


FIGURE V